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XXXIII. *Essay on the Use of the Ganglions of the Nerves: By James Johnstone, M. D. Communicated by the Right Rev. Charles Lord Bishop of Carlisle, and F. R. S.*

Read May 31, 1764. **T**HE Ganglions of the intercostal nerves, first discovered by Fallopius, are oblong and very hard bodies; the uses of which have not been satisfactorily ascertained by any one. Few anatomists have indeed entered deep into the subject, except the learned J. M. Lancisi, who imagined them muscles sui generis, and, like other muscles, capable of contractions; by which he thought the nervous spirits were accelerated and impelled with such additional forces, as are by him supposed necessary to the production of motions in muscles subject to the will: And in order to give an idea of the structure of all other Ganglions, he particularly describes and delineates that of the first cervical Ganglion (a).

This theory has the misfortune to be erroneous in its foundation. For Haller and other succeeding anatomists have not been able to discover this muscular apparatus in the first cervical Ganglion (b). The coats of Ganglions I have found with the appearance and firmness of ligaments; but incapable of such extension or retraction, as elastic muscular fibres always allow of.

(a) See Lancisi's Dissertation in Morgagni adversar.

(b) Halle, Element. Physiolog. Human. T. iv. p. 203.

Ganglions besides, instead of being instruments subservient to the will, are almost peculiar to nerves, distributed to parts, the motions of which are totally involuntary. And our author must indeed have been greatly misled by his hypothesis not to observe this striking circumstance.

The theory, which prevailed in his time and country, of the action of the dura mater upon the brain, now exploded, might lead this great man more entirely to believe an analogous muscular power in Ganglions. But the brain needs no muscular force to impress motion upon the animal spirits; and granting Ganglions to be, as is ingeniously conjectured by Lancisi and Winslow, subsidiary brains, or analogous to the brain in their office, neither will they need any such muscular apparatus and force. A power, in fine, absurd no less than chimerical, as it supposes the force of muscles of the greatest exertion and effect, to be derived from those of least bulk and strength (which must be in some proportion to the quantity of muscular fibres); and would be a single instance of a mechanical force producing another infinitely greater than itself.

1. Ganglions are observed to be formed generally upon nervous cords formed by the union of several different nerves. 2. They appear to abound with blood vessels. 3. The bulk of a Ganglion exceeds, for the most part, that of all the nerves and vessels, which it receives, and of which it may seem composed (c). Hence we may not unreasonably conclude,

(c) *Gangliorum moles major est quam sit aggregatum omnium vasorum ingredientium atque egredientium; quo fit, ut ad eorum productionem, necesse sit concurrere, præter communia vasa, peculiare aliud corpus, non tam ex cohærentia et*  
that

that in Ganglions the different nervous filaments are very intimately mixed, a new nervous organization, or modification of the medullary substance, may take place, so as to discern new animal spirits, or alter the direction of those already brought thither; a conjecture, which has the sanction of the latest as well as the earlier thoughts of the great Morgagni (*d*).

In order to determine the particular use of Ganglions (the intimate structure of which, equally with that of the brain and medullary substance of the nerves, we are hitherto ignorant of) in the animal system; let us try, if something tending this way may not be suggested, by reflecting on the functions and motions of the parts applied principally by nervous cords from below the Ganglions.

The intercostal or great sympathetic nerves abound most of all others with Ganglions (*e*); and by examining what is peculiar in the motions of parts, to which these nerves are distributed, we shall probably be led to the uses of Ganglions.

The muscular substance of the heart has its principal, or rather all its nerves, from the intercostals;

complicatione præfatorum nervorum, ac sanguiferorum, quam ex novis organicis partibus, quas provida solersque natura, subsistentibus probeq; excoctis liquidis, simul etiam elongatis, varietate dispositis, solidorum fibris, fingat et creat. Lancisi, de Gangliis, loc. cit.

(*d*) See Morgagni, *adversar. Anatom.* ii. p. 71. And *De Sedibus et Causis morborum*, Epist. xii. art. 14. p. 95, vol. I.

(*e*) Super omnes nervos, intercostali, Ganglia sunt frequentissima, in cervice quidem tria; in thorace, lumbis, et pelvi tot, quot nervorum ex spinali medulla propagines intercostalis accipit: tum in cordis vicinia, sub diaphragmate, circa arteriæ coeliacæ et mesentericæ originem: et circa renem passim in plexuosis retibus. Haller, *Elem. Phys.* T. iv. p. 202.

which

which are always detached from the principal cords below the Ganglions, and chiefly from the inferior cervical Ganglion. The few nervous cords from the par vagum or 8 pair, which in the human subject are sent towards the heart, are almost totally spread upon the pericardium and great vessels (*f*).

In the abdomen this nerve unites with the par vagum of the right side (*g*), and together form the great semi-lunar Ganglion; from which, and from other Ganglions formed in inferior parts of the abdomen, filaments are distributed to the intestines, the liver, the spleen, the kidneys; and some of them descend to the Fallopian tubes, uterus, and other parts in the pelvis; some of which are also in part furnished with filaments from the lumbar nerves.

The heart and intestines being wholly supplied by nervous filaments detached below some remarkable Ganglion, we must inquire what is particular in the motions of these parts, or in their structure: But the motions of the heart and intestines are remarkable, and exactly analogous in being involuntary, or not liable to be either stopped, renewed, or in any way controuled by the will.

Tho' it be very certain that these motions are excited in the heart by the gentle stimulus of the blood upon the infernal surface of that organ; and in the intestines by that of the secreted liquors, and of the food taken in; of which stimuli these parts have the quickest and most exquisite perception: yet this being ordinarily not so strong as to make us conscious of its action, much less painfully so, can hardly be

(*f*) Haller, Elem. Phys. T. i. p. 366.

(*g*) Winflow, Traité des Nerfs, N°. 141.

supposed to render these motions quite uncontrollable by the will, without some other efficient cause (*b*).

Anatomy discovers no peculiarity in the muscular structure of these parts likely to account for this; and, excepting in their nerves having Ganglions, which seem indeed almost appropriated to them, no anatomical difference has been observed, no mechanism, which these parts have more than those muscles, which are subject to the direction of the will.

May we not then reasonably conclude, that Ganglions are the instruments, by which the motions of the heart and intestines are, from the earliest to the last periods of animal life, rendered uniformly involuntary; and that to answer this purpose is their use, which they subserve by a structure unknown to us, no less than that of the brain, though it seems not improbable the first may be analogous to the last?

This conclusion concerning the use of Ganglions is supported by every truly parallel instance. Thus the motions of the uvea, or muscular circle of the eye, ever contracted or dilated as the eye is more or less irradiated with light, are as much involuntary as those of the heart; and it is known to anatomists, that the muscular fibres of the uvea are supplied by nerves from the lenticular Ganglion, which seems

(*b*) In the best explanation of the vital and involuntary motions, which the public has been favoured with, it is remarked by the most ingenious author, “ I imagine, that the mind’s want  
“ of power over the motion of the head is not only owing to  
“ its being continually acted upon by a stimulus, but in part to  
“ an original constitution; and that, tho’ we should suppose this  
“ organ for a little while free from every degree of irritation, yet  
“ the mind, by an effort of the will, could not move it.” Dr. Whytt’s Essay on the vital and involuntary motions of Animals, p. 316.

formed solely for the use of that muscle, and for that purpose.

That the determinations of the will are, as it were, intercepted, and prevented from reaching certain parts of the body, by the means of Ganglions, may be farther inferred by considering, that all nerves, which have a ready communication with the soul, either by affecting it with perceptions, or conveying its commands, have no Ganglions: These are never found upon the olfactory, optic, or auditory nerves, any more than upon the nerves and instruments in voluntary motion. For we may well imagine the same mechanism, which prevents the will from extending its controul to some muscles, placed upon a sensory nerve, would have equally hindered the conveyance of any sensible impression to the mind.

The left nerve of the eighth pair, distributed to the stomach, and probably the cause of the distinct and exquisite sensation of that organ, and perhaps also principally concerned in transmitting the sense of hunger to the mind, may therefore be reckoned a sensory nerve. It is certain also, that Haller (*i*) and most modern anatomists do not allow any Ganglion to this nerve, though Winslow does, and Vieussens delineates one not far from the great Ganglion of the intercostal nerve as proper to the eight pair.

If muscles subject to the will might have been totally supplied with nerves, which have Ganglions; the diaphragm had probably been entirely furnished from the intercostals, as most of the parts in the thorax above it and in the abdomen below it are. But as the motions of this muscular membrane were to be

(*i*) A. Haller, *Primæ Lin. Physiolog.* N°. 377.

controulable by the will, we find peculiar nerves, namely the phrenic, which have no Ganglions sent to it from a great distance.

In proposing this as the probable use of Ganglions, I am far from thinking it entirely exempt from difficulties; but they are chiefly such, as arise from our imperfect knowledge of the nerves in general; a terra incognita, which remains to immortalize the name of some future discoverer in anatomy. It is well known, for instance, that all the nerves sent from the spinal marrow have Ganglions, where they send off the branch, which communicates with the intercostals (*k*). Though this be true, it is most probable, that these Ganglions respect the intercostals, and only affect its nerves, leaving the other fibres fit and free for the conveyance of the commands of the will, as in fact many of them are distributed to muscles under its power and direction.

So likewise we are not to imagine, wherever the nerves unite, that their medullary substance either decussates, or is so intimately mixed, as is reasonably supposed to be the case in Ganglions by most anatomists from Lancisi down to Haller. We know at least, that this is far from being the case in the optic nerves; for though they unite, and were supposed to cross each other, the contrary appears by observations made in the bodies of persons, who were blind of one eye, from a fault in the optic nerve, the nerve of the affected side only being wasted, while the other was large and plump (*l*). And we may justly infer the

(*k*) See the table of Vieussens.

(*l*) See Monro's Anatomy, p. 356; also N<sup>o</sup> 23, of the nerves in general.



plexiform unions of the nerves distributed to the superior extremities not more intimate, nor to serve any such purpose as Ganglions, since these nerves are equally motory and sensory, no other nerves being distributed to the skin, the organ of touch, but from the subdivision of these plexuses.

Kidderminster,  
Nov. 24, 1763.

James Johnstone, *M. D.*